

condition of the Society. The address of the president, Mr. T. Southwell, is on the Extinction of Native Races. Among other papers of interest are: "Notes on Collecting Lepidoptera in Norfolk, 1878," by Mr. F. D. Wheeler; "Discovery of Remains of *Emys lutaria* in the Mundesley River-bed," by Mr. H. B. Woodward; The Bird-Life and the Geology of the Shiant Isles, by Mr. Harvie-Brown and Prof. Heddle respectively; Notes on Hawking in Norfolk, by Prof. Newton and Mr. J. E. Harting; Ornithological Notes and Meteorological Observations.

THE *Proceedings* of the Liverpool Naturalists Field Club for 1879-80 contains notes of the excursions and meetings of the Society. The only papers given are by the president, the Rev. H. H. Higgins, one being "Biographical Sketches in Zoology, from its Origin to its Union with Botany in the Science of Biology."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. Anson; a Side-Striped Jackal (*Canis lateralis*) from East Africa, presented by Commander Owen, R.M.S. *Anglian*; a Common Ocelot (*Felis pardalis*) from Mexico, presented by Mr. A. L. Schütte; two Common Peafowls (*Pavo cristata*) from India, presented by Mrs. Joseph Hoare; four Globose Curassows (*Crax globicera*), a Little Guan (*Ortalia motmot*) from British Honduras, presented by Mr. F. P. Barlee, C.M.G.; ten Amaduvade Finches (*Estrela amandava*) from India, presented by Mr. J. W. Wilson; a Mississippi Alligator (*Alligator mississippiensis*) from North America, presented by Mr. T. L. M. Rose; two Horrid Rattlesnakes (*Crotalus horridus*) from Nicaragua, presented by Messrs. Holt, Lord, and Co.; an Anaconda (*Eunectes murinus*) from South America, presented by Mr. G. H. Hawtayne; a Bonnet Monkey (*Macacus radiatus*) from India, an Arctic Fox (*Canis lagopus*) from the Arctic regions; a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, deposited; a Nylghaie (*Boselaphus pictus*) from India, a Collared Peccary (*Dicotyles tajacu*) from South America, two Common Otters (*Lutra vulgaris*, *ju.*), British; a Ground Hornbill (*Bucorvus abyssinicus*), an Elate Hornbill (*Buceros elatus*) from West Africa, a Virginian Eagle Owl (*Bubo virginianus*) from North America, a White-necked Crow (*Corvus scapularis*) from Africa, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

ON CURRENTS PRODUCED BY FRICTION BETWEEN CONDUCTING SUBSTANCES, AND ON A NEW FORM OF TELEPHONE RECEIVER¹

IN a communication to the Royal Society of Edinburgh of date January 6, 1879, I showed that "electric currents were produced by the mere friction between conducting substances." The existence of these currents can be easily demonstrated either by a telephone or a Thomson's galvanometer. I have since found that these currents are, for all pairs of metals which I have yet tried, in the same direction as the thermo-electric current got by heating the junction of the same two metals. They are also, approximately at least, stronger in proportion as the metals rubbed are far apart on the thermo-electric scale—the strongest current, as far as I have yet observed, being got by rubbing antimony and bismuth together. These observations clearly point to a thermo-electric origin for the currents; but it is possible that they may be due partly to the currents suggested by Sir William Thomson as the cause of friction, and partly, also, to contact force between films of air or oxide adhering to the surfaces of the metals.

Having ascertained that these friction-currents are of some strength and fairly constant, I proceeded to make several kinds of machine for producing currents on this principle. One of them consists of a cylinder of antimony, which can be rotated rapidly, while a plate of bismuth is pressed hard against it by a

¹ Abstract of a paper read before the Royal Society of Edinburgh by James Blyth, M.A., F.R.S.E., on May 3, 1880.

stiff spring. When this machine is included in the same circuit with a microphone and a Bell telephone, the current got from it is quite sufficient to serve for the transmission of musical sounds and also loud speaking. The transmitter, which I have found most serviceable in my experiments, is made by screwing two small cubes of gas-carbon to a violin, and placing between them a long stick of carbon pointed at both ends, the points being made to rest in conical holes in the carbon cubes. The looseness of the contact is regulated by a paper spring. This forms an excellent and handy transmitter for all kinds of musical sounds, and also serves very well for transmitting speech.

Seeing that friction between metals clearly produces a current, it seemed natural to inquire if the converse held good, that is, if a current from a battery sent across the junction of two metals affected the friction of the one upon the other. I have tested for this in a variety of ways, and the results obtained leave me in doubt whether to attribute them to variations in the friction, or to actual sticking produced by fusion of the points of contact through which the current passes. The most noticeable effect is produced when one of the rubbing bodies is a mere point, and the other a smooth surface of metal. This led me to make a modification of the loud-speaking telephone of Mr. Edison, in order to get audible indications of changes of friction produced by the passing of a variable current. It consists of a cylinder of bismuth accurately turned and revolving on centres. The rubbing-point is made of a sewing-needle with its point bent at right angles, and its other end attached to the centre of the mica disk of a phonograph mouthpiece. It is evident that this is only a loose contact, which can be perpetually changed. When this apparatus is included in the circuit with the violin-microphone and three or four Bunsen cells, the violin sounds, as was to be expected, are heard proceeding from the loose-contact, even when the cylinder is not rotated. They are increased, however, in a remarkable degree by rotating the cylinder slowly, so much so that a tune played on the violin can, with proper care, be distinctly heard all over an ordinary room.

With regard to the explanation of this effect, it is evident, that electrolysis can in no sense come into play, as is supposed to be the case in Edison's instrument. I am inclined to look for the explanation rather in the direction of the Trevelyan rocker, although the circumstances are considerably different in the two cases. In the rocker we have the heat passing from a mass of hot metal through two points of support to a cold block, whereas, in the other case, the heat is only intense at the points of contact, the rest of the metals being comparatively unaffected. The variations in the current produced by the transmitting microphone must cause corresponding variations in the heat at the point of contact of the needle with the cylinder, and this again produces a mechanical movement of the pressing point, as well as of the air surrounding it, sufficient to give forth sound-waves. If such be the case the effect should be different for different metals, those answering best which have the lowest thermal conductivity and also the lowest specific heat. That this is really so is shown by substituting cylinders of other metals for the bismuth, all other things remaining the same. In this way I have compared lead, tin, iron, copper, carbon, and find that they all give forth the simple loose contact-sound when the cylinder is stationary, but that it is only with bismuth that there is any very great intensification of the sound when the cylinder is rotated. Now, by consulting the appropriate tables I find that bismuth is a fraction lower than any other common metal in specific heat, while it is much below them all in thermal conductivity. This seems to bear out my explanation to a certain extent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The subject for the Sedgwick Prize essay, 1883, is "The Classification of the Cambrian and Silurian Rocks." The prize is open to all graduates of the University of Cambridge who have resided sixty days during the twelve months preceding October 1, 1882. The essays must be sent in to the Registry on or before October 1, 1882.

SCIENTIFIC SERIALS

Proceedings of the Academy of Natural Sciences of Philadelphia. Part I, January to April.—Thomas Meehan, on disarticulating branches in Ampelopsis (the annual growth is dis-

articulated at just one node above that one made the previous year, the branch thus gaining but one node in the year. This reminds one of the South Pacific *Vitis*, which produces tubers on the end of the branches, and at the end of each season disarticulates them).—On germination in acorns (in *Quercus virens*, Mr. Mazyck has noticed that the two petioles instead of being short were produced to a length of $1\frac{1}{2}$ inches before the plumule and hypocotyledonary portions of the young plant commenced their growth, and a small tuberosus projection nearly one-fourth the size of the acorn preceded the growth downwards of the radicle and upwards of the plumule. The cells in all of these were gorged with starch).—Dr. Leidy, notice of *Filaria immitis* in the dog, and on a *Filaria* reported to have come from a man.—W. N. Lockington, on the Pacific species of *Caulolatilus*.—Heilprin, Angelo, on the stratigraphical evidence afforded by the tertiary fossils of the peninsula of Maryland.—J. S. Kingsley, carcinological notes: I. (chiefly relates to the genus *Thelphusa*, describes two new species from Ceylon and one from West Africa; also a new species of *Dilocarcinus*. II. Revision of the *Gelasini*, plates 9 and 10).—Dr. Allen, description of a foetal walrus, and on the mammae of bats.—Dr. R. Bergh, on the nudibranchs of the North Pacific Ocean, with special reference to those of Alaska, Part 2, plates 1 to 8.—Howard Kelly, on a sartorius muscle in the gorilla. This muscle was reinforced six inches from its origin by a muscular slip a quarter of an inch in breadth; it arose at the lower part of the middle third of the femur, between the origin of the quadriceps extensor and the insertion of the adductors joining the sartorius opposite the knee joint.—J. H. Redfield, on *Rochelia patens* (Nuttall), decided by Dr. Gray to be *Echinosperrum floribundum*.—Report on plants introduced by means of the International Exhibition 1876.

Bulletins de la Société d'Anthropologie de Paris, tome 3, fasc. 1, 1880.—The present number contains the address of M. Sanson, president of the Society for 1880.—A communication from M. Mantegazza, on the Lapps.—A paper by M. Emile Goldi, on the migration of races in Egypt, which gave rise to an animated discussion, in which M. C. Royer opposed the author's view of the Asiatic origin of the Egyptian races.—M. Topinard proposed new methods for obtaining means differing from those suggested by M. Broca, which he considers to be based upon too small numbers.—M. Robin, Inspector of Primary Instruction in the Département de Loir-et-Cher, invites the attention of the Society to the question whether it would not be desirable, to require from teachers in the public schools reports of the stature, growth, &c., of the pupils under their observation. M. Broca was of opinion that anthropological characteristics are of little value except in the case of adults, and that the important question of growth can only be satisfactorily considered when large numbers of children are simultaneously submitted to observation.—This number of the *Bulletins* devotes nearly seventy pages to the reprint of the "Inventory of the Megalithic Monuments of France," in which we have the combined result of the carefully-conducted observations of the General Commission for the registration of these remains, which was formally appointed by the Minister for Public Instruction in November, 1879. In this survey the country was divided into six sections, each of which was placed under the direction of one of the commissioners, while the general work was further subdivided into two groups, those of erratic boulders and megalithic monuments.—The last paper, by M. Paul Broca (on a new instrument invented by himself, and named "le goniomètre d'inclinaison et l'orthogone"), has a specially melancholy interest from the fact that it is connected with some of the latest work done by this eminent savant before his death.

Journal of the Franklin Institute, July.—The belt-dynamometer of Dr. C. W. Siemens, by R. Briggs.—High railway speeds, by W. B. Le Van.—Economic vaporisation of a boiler, by Chief Engineer Isherwood.—Progress of the dephosphorisation of iron, by F. Gautier.—The involute of the circumference of a circle, by L. D'Auria.—A new pendulum suspension, by L. H. Speller.—The puddling process, past and present, by P. Roberts, jun.

Bulletin de l'Académie Royale des Sciences (of Belgium), No. 5.—On a whale caught on the coast of Charleston (South Carolina) on January 7, 1880, by M. Van Beneden.—An application of accidental images, by M. Plateau.—Note on the illumination of mines with phosphorescent sulphides, by M. Montigny.—Researches on the property possessed by solid bodies

of welding by the action of pressure, by M. Spring.—On the line of (so called) helium, by Abbé Spée.—Excretory apparatus of the Trematodes and Cestoides, by M. Fraipont.—Discovery of hæmoglobin in the aquiferous system of an Echinoderm, by M. Foeltinger.

SOCIETIES AND ACADEMIES

EDINBURGH

Royal Society, June 21.—Prof. MacLagan, M.D., vice-president, in the chair.—Prof. Chrystal read a paper on a differential telephone, and on the application of the telephone to electrical measurements. A differential telephone was exhibited. It differed from an ordinary telephone in much the same way that a differential galvanometer differs from an ordinary single-coiled one. Two thin wires were twisted together and wound round the magnet in the usual way. It was shown that when an interrupted current passed in opposite directions through the two coils of the differential telephone no sound was heard. In using the instrument, its two coils were put into the two branches of a multiple arc, which was inserted in the circuit of the interrupted current. The interrupted currents of the two branches passed in opposite directions through the coils. The conditions for perfect compensation were not only that the resistances of the two branches must be equal, but also that their co-efficients of self-induction must be the same. If only one of these conditions was fulfilled a minimum of sound could be got, but absolute silence was impossible. The necessity for this twofold adjustment had not been hitherto sufficiently recognised; and it was to its neglect that the main difficulties in using Hughes' induction-balance were no doubt to be referred. Some years ago Prof. Chrystal had worked out the mathematics of the subject, but had been unable till recently to corroborate his results by experiment. Prof. Chrystal then proceeded to indicate how such a differential telephone could be applied to the measurement of coefficients of self-induction in terms of an arbitrary unit. Two coils were prepared of exactly the same resistance, but one was so wound as to have practically no self-induction. The self-induction of the other was the arbitrary unit mentioned above. In the rough model shown, two coils, whose distance apart could be varied at will, were introduced into each branch of the multiple arc above referred to, and were first adjusted so as to produce perfect compensation in the differential telephone. The other two equal resistance-coils were then introduced, one into the circuit of each induction pair, with the necessary effect of destroying the compensation. By a readjustment of the induction of one of the pairs, compensation was again secured, the change of distance of the coils of the altered pair corresponding therefore to the arbitrary unit. The two single coils were then removed, a fresh compensation obtained by alteration of the other induction pair, the single coils again introduced, a fourth compensation effected and a second stage reached in the formation of a graduated scale of self-induction in terms of an arbitrary unit; and so on till a complete scale was formed. Prof. Chrystal further pointed out how his instrument might be used for measuring capacities, and for investigating the real nature of the opposition offered by electrolytes to the passage of electric currents.—Prof. Tait communicated a paper on the determination of the specific heats of saline solutions, by Mr. Thomas Gray, B.Sc.—Mr. J. Y. Buchanan described a "navigational sounding-machine" of very simple construction. A glass tube, closed below by a plug kept sufficiently tight by a close-fitting india-rubber band, was provided above with a peculiarly-formed capillary orifice. The tube was first allowed to fill with air, and then sunk to the required depth in the sea. The air was compressed under the increased pressure, and the water began to trickle in from above. The quantity of water which so gained admittance was the datum from which the pressure, and therefore the depth, could be calculated. The water was removed by taking away the bottom plug; and the instrument was once more in a state suitable for use. Mr. Buchanan also communicated some experiments on the compressibility of glass. The value he obtained was greater than that obtained by Grassi by $2\frac{1}{2}$ per cent.—Dr. Macfarlane read a short paper entitled "Suggestions on the Art of Signalling." He advocated the use of three qualities or symbols in preference to the dot-and-dash or two-symbolled alphabet of Morse, arguing that such a system would be found more rapid than the latter.—Dr. R. M. Ferguson communicated a note on the wire telephone, following